J. Helminthol. Soc. Wash.
61(1), 1994, pp. 73–83

Gastrointestinal Helminths of *Sceloporus* Lizards (Phrynosomatidae) from Arizona

STEPHEN R. GOLDBERG,[1] CHARLES R. BURSEY,[2] AND RANA TAWIL[1]

[1] Department of Biology, Whittier College, Whittier, California 90608 and
[2] Department of Biology, Pennsylvania State University, Shenango Valley Campus, 147 Shenango Avenue, Sharon, Pennsylvania 16146

ABSTRACT: Five species of Arizona spiny lizards were examined for gastrointestinal helminths. *Sceloporus clarkii* ($N = 20$) harbored the cestodes *Mesocestoides* sp. and *Oochoristica scelopori* and the nematodes *Atractis penneri, Physaloptera retusa, Piratuba prolifica, Skrjabinoptera phrynosoma,* and *Spauligodon giganticus. Sceloporus magister* ($N = 15$) harbored *A. penneri, Ph. retusa,* and *Sk. phrynosoma. Sceloporus undulatus consobrinus* ($N = 30$) harbored *O. scelopori* and *Ph. retusa. Sceloporus undulatus tristichus* ($N = 18$) harbored *Mesocestoides* sp., *Ph. retusa,* and *Sp. giganticus. Sceloporus virgatus* ($N = 23$) harbored *A. penneri* and *Ph. retusa.* No helminths were recovered from *Sceloporus graciosus* ($N = 20$). *Sceloporus clarkii* is a new host record for *Mesocestoides* sp., *O. scelopori, Ph. retusa, Pi. prolifica,* and *Sk. phrynosoma. Sceloporus undulatus consobrinus* is a new host record for *O. scelopori. Sceloporus undulatus tristichus* is a new host record for *Mesocestoides* sp. *Sceloporus virgatus* is a new host record for *A. penneri* and *Ph. retusa.* The highest prevalence in the study (55%) was recorded for *Ph. retusa* in *S. clarkii.* The highest mean intensity (1,682) was recorded for *A. penneri* in *S. magister.* It appears that larger species of sceloporine lizards have more diverse helminth faunas than smaller species.

KEY WORDS: Cestoda, *Mesocestoides* sp., *Oochoristica scelopori,* Nematoda, *Atractis penneri, Physaloptera retusa, Piratuba prolifica, Skrjabinoptera phrynosoma, Spauligodon giganticus,* Phrynosomatidae, *Sceloporus,* prevalence, intensity, survey.

Seven species of lizards in the genus *Sceloporus* occur in Arizona (Stebbins, 1985). *Sceloporus scalaris* Wiegmann, 1828, *Sceloporus virgatus* Smith, 1938, and *Sceloporus jarrovii* Cope, 1875, are mountain species restricted to elevations above 1,500 m. *Sceloporus clarkii* Baird and Girard, 1852, is found on lower mountain slopes usually below elevations of 1,500 m. *Sceloporus magister* Hallowell, 1854, is found on arid plains. *Sceloporus undulatus* (Bosc and Daudin, 1801), represented by subspecies *S. u. consobrinus* Baird and Girard, 1853, and *S. u. tristichus* Cope, 1875, is found in a variety of habitats. *Sceloporus graciosus* Baird and Girard, 1852, occurs in brushlands but is restricted to northern Arizona.

Several reports on helminths from these lizards are available: Gambino (1958), Gambino and Heyneman (1960), and Goldberg and Bursey (1992c) for *S. clarkii*; Goldberg and Bursey (1990a, 1992c) and Bursey and Goldberg (1991a, b, 1992a) for *S. jarrovii*; Walker and Matthias (1973) and Benes (1985) for *S. magister*; and Goldberg and Bursey (1992b) for *S. scalaris.* To our knowledge, there are no published reports of helminths from *S. graciosus, S. undulatus,* and *S. virgatus* from Arizona, although reports of helminths from *S. graciosus* in California (Stebbins and Robinson, 1946; Goldberg and Bursey, 1989b, c), in Utah (Woodbury, 1934; Pearce and Tanner, 1973) and from *S. undulatus* from Utah (Pearce and Tanner, 1973) have been published. The purpose of this article is to present data on helminths from 5 species of sceloporine lizards from Arizona and to compare helminth infections among the various species of Arizona lizards.

Materials and Methods

Sceloporus clarkii were borrowed from the Herpetology Collection, Natural History Museum of Los Angeles County (LACM) and from the Museum of Northern Arizona (MNA); *S. graciosus* were borrowed from the LACM and Monte L. Bean Life Science Museum, Brigham Young University (BYU); and *S. magister, S. undulatus consobrinus, S. undulatus tristichus,* and *S. virgatus* were borrowed from the LACM. The number of specimens of each species examined, body sizes as snout–vent length, and collection dates are given in Table 1. Museum accession numbers and collection site latitudes, longitudes, and elevations are given in the Appendix.

The body cavity was opened by a longitudinal incision from vent to throat, and the gastrointestinal tract was excised by cutting across the anterior esophagus and rectum. The esophagus, stomach, and small and large intestines were slit longitudinally and examined under a dissecting microscope. Each helminth was examined and identified using a glycerol wet mount. Selected cestodes were stained with hematoxylin and mounted in balsam. Representative specimens were deposited in the U.S. National Parasite Collection, Beltsville, Maryland 20705 (see the Appendix for accession numbers).

Table 1. Collection locality, year of collection, and mean size of the sceloporine lizards examined in this study.

Species	County	*N*	Year	Mean snout–vent length (mm)	Range (mm)
Sceloporus clarkii	Gila	1	1992	49	—
	Mohave	1	1992	103	—
	Pima	9	1966, 1967, 1991	91	78–98
	Pinal	4	1967	94	86–117
	Yavapai	5	1967	92	85–97
S. graciosus	Coconino	13	1984	39	34–52
	Navajo	7	1966	48	41–52
	—*	1	1983	56	—
S. magister	Gila	1	1992	109	—
	Mohave	2	1992	98	87–109
	Pima	9	1966, 1967, 1969	93	68–114
	Pinal	1	1967	124	—
	Yavapai	2	1967, 1969	72	48–95
S. undulatus consobrinus	Pinal	30	1967, 1969	56	43–65
S. u. tristichus	Pima	18	1967	55	33–68
S. virgatus	Cochise	23	1967	46	31–64

* The 1 infected specimen was from Washington County, Utah.

Results and Discussion

Two species of cestode, *Mesocestoides* sp. (as tetrathyridia) and *Oochoristica scelopori* Voge and Fox, 1950, and 5 species of nematodes, *Atractis penneri* (Gambino, 1957) Baker, 1987, *Physaloptera retusa* Rudolphi, 1819, *Piratuba prolifica* Pelaez and Perez-Reyes, 1958, *Skrjabinoptera phrynosoma* (Ortlepp, 1922) Schulz, 1927, and *Spauligodon giganticus* (Read and Amrein, 1953) Skrjabin, Schikhobalova and Lagodovskaja, 1960, were recovered during the course of this study. Prevalences and mean intensities (Margolis et al., 1982) and infection sites for helminths occurring in Arizona lizards (including this study) are given in Table 2.

Of the 44 species of lizards in Arizona (Stebbins, 1985), 31 are now reported to harbor at least 20 species of helminths in 13 genera (Table 2). We question the validity and have therefore deleted *Alaeuris* sp. (reported by Benes, 1985), *Spauligodon* (=*Pharyngodon*) *extunatus (reported by Hannum, 1941), Spauligodon* (=*Pharyngodon*) *oxkutzcabiensis* (reported by Benes, 1985), and *Macracis* sp. and *Ozolaimus* sp. (reported by Benes, 1985) from the Arizona helminth list. Ten species of *Alaeuris* have been reported from coastal environments of North America (California, Florida, and Georgia) (Baker, 1987), but there are no other reports of *Alaeuris* sp. from Arizona and no reports of another species of *Cnemidophorus* infected by a species of *Alaeuris*. We prefer to think of Benes' (1985) report of *Alaeuris* sp. in terms of "an oxyurid species." *Spauligodon* (=*Pharyngodon*) *extenuatus* and *S.* (=*P.*) *oxkutzcabiensis* are unknown from North America (Baker, 1987), *S. extenuatus* is known only from Spain, Italy, and North Africa, and *S. oxkutzcabiensis* is known only from Central America. We prefer to think of these nematodes as *Pharyngodon* sp. The genus *Macracis* was synonymized with the genus *Ozolaimus* by Inglis et al. (1960) and *Ozolaimus* is unknown from mainland North America (Baker, 1987). Again, we refer to the report of this genus as "an oxyurid species." We believe the *Oochoristica* sp. reported by Benes (1985) in *Phrynosoma solare* to be *Diochetos phrynosomatis* and have recorded it as such.

Tetrathyridia of *Mesocestoides* sp. have previously been reported from 35 species of lizards from 9 states and Mexico (Goldberg and Bursey, 1990c; McAllister, 1991; McAllister et al., 1991a, b). Of the 44 species of lizards found in Arizona, tetrathyridia of *Mesocestoides* sp. have been reported previously from 7 species (2 teiid and 5 phrynosomatid). This report brings the total number of Arizona lizard species infected to 9, 2 teiid and 7 phrynosomatid. Tetrathyridia are most commonly seen in the body cavity, although they may invade the viscera (Goldberg, 1985) as well as skeletal muscle (Goldberg et al., 1993d). The life cycle of species in the genus *Mesocestoides* is incompletely known, but adults are intestinal parasites of carnivorous birds and mammals. The first intermediate host is an arthropod, probably an insect (Webster, 1949).

Table 2. Helminths recovered from Arizona lizards.

Host Helminth	Prevalence	Mean intensity (range)	Site	Reference
Callisaurus draconoides ventralis				
Atractis sp.	50% (1/2)	71 —	Large intestine	Benes, 1985
Cnemidophorus sp.				
Pharyngodon papillocauda	—	— —	—	Hannum, 1941
Cnemidophorus burti stictogrammus				
Mesocestoides sp.	2% (1/57)	— —	Liver, ovary, mesenteries	Goldberg, 1987
Oochoristica bivitellobata	2% (1/57)	1 —	Small intestine	Goldberg and Bursey, 1989a
Physaloptera retusa	14% (8/57)	2 (1–5)	Stomach	Goldberg and Bursey, 1989a
Pharyngodon cnemidophori	5% (3/57)	26 (18–35)	Large intestine	Goldberg and Bursey, 1989a
Thubunaea cnemidophorus	4% (2/57)	2 (1–3)	Stomach	Goldberg and Bursey, 1989a
Skrjabinoptera phrynosoma	2% (1/57)	1 —	Stomach	Goldberg and Bursey, 1989a
Cnemidophorus inornatus arizonae				
Oochoristica bivitellobata	13% (10/78)	2 (1–4)	Small intestine	Goldberg and Bursey, 1990b
Pharyngodon warneri	23% (18/78)	15 (1–73)	Large intestine	Goldberg and Bursey, 1990b
Physaloptera sp. (larvae)	1% (1/78)	2 —	Stomach	Goldberg and Bursey, 1990b
Cnemidophorus sonorae				
Oochoristica bivitellobata	7% (1/14)	5 —	Small intestine	McAllister, 1992
Physaloptera sp. (larvae)	29% (4/14)	1 (1–3)	Stomach	McAllister, 1992
Acanthocephalan larva	7% (1/14)	1 —	Coelom	McAllister, 1992
Cnemidophorus tigris				
Mesocestoides sp.	2% (1/50)	2 —	Small intestine	Benes, 1985
Oochoristica sp.	6% (3/50)	— (1–3)	Small intestine	Benes, 1985
Pharyngodon warneri	67% (4/6)	— —	Large intestine	Babero and Matthias, 1967
Oxyurid nematodes	4% (2/50)	29 (7–45)	Small and large intestine	Benes, 1985
Acanthocephalan larvae	2% (1/50)	4 —	Coelom	Benes, 1985
Cnemidophorus uniparens				
Oochoristica bivitellobata	26% (8/31)	2 (1–8)	Small intestine	Goldberg and Bursey, 1990b
Acanthocephalan larva	3% (1/31)	1 —	Stomach	Goldberg and Bursey, 1990b
Coleonyx variegatus				
Oochoristica sp.	8% (4/53)	— (1–3)	Small intestine	Benes, 1985
Pharyngodon sp.	36% (19/53)	— (2–61)	Large intestine	Benes, 1985
	— (2/?)	total of 32	—	Hannum, 1941

Table 2. Continued.

Host Helminth	Prevalence	Mean intensity (range)	Site	Reference
Thubunea sp.	2% (1/53)	2 —	Stomach	Benes, 1985
Spirurid larvae	8% (4/53)	— (1–9)	Stomach and large intestine	Benes, 1985
Cophosaurus texanus scitulus				
Oochoristica sp.	2% (1/53)	1 —	Small intestine	Goldberg and Bursey, 1992a
Oochoristica sp.	— (?/3)	— —	—	Walker and Matthias, 1973
Atractis penneri	— (?/3)	— —	—	Walker and Matthias, 1973
Thubunaea iguanae	8% (4/53)	3 (1–8)	Stomach	Goldberg and Bursey, 1992a
Acanthocephalan larva	2% (1/53)	1 —	Small intestine	Goldberg and Bursey, 1992a
Dipsosaurus dorsalis dorsalis				
Atractis scelopori	100% (2/2)	— many	Large intestine	Benes, 1985
Heloderma suspectum				
Oochoristica whitentoni	2% (2/110)	3 (1–40)	Small intestine	Goldberg and Bursey, 1991b
Oswaldocruzia pipiens	5% (6/110)	20 (1–67)	Small intestine	Goldberg and Bursey, 1991b
Piratuba prolifica (larvae)	100% (1/1)	— —	Liver	Goldberg and Bursey, 1991b
Skrjabinoptera phrynosoma	5% (6/110)	3 (1–8)	Stomach	Goldberg and Bursey, 1991b
Splendidofilaria corophila	– (1/?)	— —	—	Hannum, 1941
Holbrookia maculata				
Oochoristica sp.	— (?/40)	— —	—	Walker and Matthias, 1973
Atractis penneri	65% (11/17)	— —	Large intestine	Gambino and Heyneman, 1960
	— (?/40)	— —	—	Walker and Matthias, 1973
	13% (2/15)	61 (31–91)	Large intestine	Goldberg and Bursey, 1992a
Physaloptera sp. (larvae)	7% (1/15)	4 —	Stomach	Goldberg and Bursey, 1992a
Phrynosoma cornutum				
Diochetos phrynosomatis	71% (5/7)	86 (22–181)	Small and large intestine	Goldberg et al., 1993a
Atractis penneri	14% (1/7)	137 —	Large intestine	Goldberg et al., 1993a
Skrjabinoptera phrynosoma	86% (6/7)	611 (9–1,579)	Stomach	Goldberg et al., 1993a
Phrynosoma douglassii				
Diochetos phrynosomatis	— (?/2)	— —	—	Walker and Matthias, 1973

Table 2. Continued.

Host Helminth	Prevalence	Mean intensity (range)	Site	Reference
Atractis penneri	11% (2/19)	476 (323–636)	Small and large intestine	Goldberg et al., 1993a
Skrjabinoptera phrynosoma	11% (2/19)	47 (34–60)	Stomach and small intestine	Goldberg et al., 1993a
Phrynosoma modestum				
Skrjabinoptera phrynosoma	80% (4/5)	5 (1–13)	Stomach, small intestine, lung	Goldberg et al., 1993a
Phrynosoma platyrhinos				
Atractis penneri	40% (2/5)	511 (396–625)	Large intestine	Goldberg et al., 1993a
Skrjabinoptera phrynosoma	40% (2/5)	8 (6–10)	Stomach	Goldberg et al., 1993a
Phrynosoma solare				
Diochetos phrynosomatis	100% (8/8)	30 (21–70)	Small intestine	Goldberg et al., 1993a
	29% (4/14)	— (63–250)	Small intestine	Benes, 1985
Atractis penneri	75% (3/4)	— —	Large intestine	Gambino and Heyneman, 1960
	21% (3/14)	— (58–1,258)	Large intestine	Benes, 1985
	63% (5/8)	1,113 (2–2,364)	Large intestine	Goldberg et al., 1993a
Skrjabinoptera phrynosoma	75% —	— —	—	Hannum, 1941
	79% (11/14)	— (1–360+)	Stomach	Benes, 1985
	100% (8/8)	524 (16–1,804)	Stomach and intestines	Goldberg et al., 1993a
Sauromalus obesus obesus				
Atractis scelopori	100% (1/1)	— —	Large intestine	Gambino and Heyneman, 1960
Atractis sp.	100% (2/2)	— many	Large intestine	Benes, 1985
Sceloporus clarkii				
Mesocestoides sp.*	5% (1/20)	32 —	Coelom	This study
*Oochoristica scelopori**	5% (1/20)	2 —	Small intestine	This study
Atractis penneri	50% (1/2)	— —	Large intestine	Gambino and Heyneman, 1960
	35% (7/20)	330 (1–997)	Large intestine	This study
*Physaloptera retusa**	55% (11/20)	14 (1–76)	Stomach	This study
*Piratuba prolifica**	10% (2/20)	2 (2)	Coelom	This study
*Skrjabinoptera phrynosoma**	30% (6/20)	48 (9–94)	Stomach	This study
Spauligodon giganticus	10% (3/20)	3 (2–4)	Large intestine	This study

Table 2. Continued.

Host Helminth	Prevalence	Mean intensity (range)	Site	Reference
Sceloporus jarrovii jarrovii				
Mesocestoides sp.	3% (15/489)	5 (1–22)	Coelom	Goldberg and Bursey, 1990a
Oochoristica scelopori	10% (47/489)	2 (1–10)	Small intestine	Goldberg and Bursey, 1990a
	3% (1/31)	7 —	Small intestine	Goldberg and Bursey, 1992c
Physaloptera retusa	34% (167/489)	12 (1–271)	Stomach and intestines	Goldberg and Bursey, 1990a
Spauligodon giganticus	94% (459/489)	20 (1–258)	Small and large intestines	Goldberg and Bursey, 1990a
	74% (23/31)	— —	Stomach and intestines	Goldberg and Bursey, 1992c
Thubunaea intestinalis	3% (16/489)	3 (1–8)	Small intestine	Bursey and Goldberg, 1991b
Acanthocephalus sp.	1% (3/489)	1 —	Small and large intestines	Goldberg and Bursey, 1990a
Sceloporus magister				
Mesocestoides sp.	2% (1/52)	124 —	Coelom and liver	Benes, 1985
Oochoristica scelopori	— (?/3)	— —	—	Walker and Matthias, 1973
Oochoristica sp.	4% (2/52)	1 —	Small intestine	Benes, 1985
Atractis penneri	— (?/3)	— —	—	Walker and Matthias, 1973
	33% (5/15)	1,682 (24–5,048)	Large intestine	This study
Physaloptera retusa	— (?/3)	— —	—	Walker and Matthias, 1973
	13% (2/15)	2 (1–3)	Stomach	This study
Physaloptera sp. (larvae)	2% (1/52)	2 —	Stomach	Benes, 1985
Skrjabinoptera phrynosoma	— (1/?)	— —	—	Hannum, 1941
	2% (1/52)	2 —	Stomach	Benes, 1985
	33% (5/15)	12 (1–33)	Stomach	This study
Thubunea sp.	2% (1/52)	2 —	Stomach	Benes, 1985
Sceloporus scalaris slevini				
Mesocestoides sp.	8% (3/38)	39 (8–58)	Coelom	Goldberg and Bursey, 1992b
Physaloptera sp.	3% (1/38)	6 —	Stomach	Goldberg and Bursey, 1992b
Sceloporus undulatus consobrinus				
*Oochoristica scelopori**	10% (3/30)	6 (2–1)	Small intestine	This study
Physaloptera retusa	7% (2/30)	2 (2)	Stomach	This study
Sceloporus undulatus tristichus				
Mesocestoides sp.*	11% (2/18)	399 (203–595)	Coelom	This study
Physaloptera retusa	6% (1/18)	1 —	Stomach	This study
Spauligodon giganticus	22% (4/18)	8 (1–21)	Large intestine	This study

Table 2. Continued.

Host Helminth	Prevalence	Mean intensity (range)	Site	Reference
Sceloporus virgatus				
*Atractis penneri**	13% (3/23)	118 (106–125)	Large intestine	This study
*Physaloptera retusa**	52% (12/23)	3 (1–5)	Stomach	This study
Urosaurus ornatus				
Mesocestoides sp.	1% (1/100)	3 —	Coelom	Benes, 1985
Pharyngodon warneri	— (?/3)	— —	—	Walker and Matthias, 1973
Pharyngodon sp.	9% (9/100)	— (1–141)	Large intestine	Benes, 1985
Spauligodon giganticus	20% (3/15)	4 (1–9)	Large intestine	Goldberg et al., 1993d
Uta stansburiana stejnegeri				
Mesocestoides sp.	7% (7/100)	— (5–293+)	Coelom and liver	Benes, 1985
Oochoristica sp.	3% (3/100)	— (1–2)	Small intestine	Benes, 1985
Thubunea sp.	4% (4/100)	— (1–4)	Stomach	Benes, 1985

* New host record.

Whether lizards are important intermediate hosts or are only paratenic hosts is yet to be determined. McAllister et al. (1992) administered tetrathyridia recovered from *Sceloporus undulatus hyacinthinus* from Arkansas to hamsters and recovered gravid adult *Mesocestoides lineatus*, a common parasite of raccoons. Such studies have not yet been performed on tetrathyridia recovered from Arizona lizards. *Sceloporus clarkii* and *S. undulatus tristichus* are new host records for tetrathyridia of *Mesocestoides* sp. (Table 2).

Oochoristica scelopori, 1 of 14 species of *Oochoristica* reported from North America, is known from 9 crotaphytid and phrynosomatid lizards from 5 western states (see Bursey and Goldberg, 1992b). It previously had been reported in only 2 species from Arizona, *S. jarrovii jarrovii* by Goldberg and Bursey (1990a) and *S. magister* by Walker and Matthias (1973). This report brings the total number of species infected in Arizona to 4, all sceloporine lizards. *Oochoristica scelopori* is replaced by *Oochoristica bivitellobata* in some species of *Cnemidophorus* spp. (Goldberg and Bursey, 1990b), by *Oochoristica whitentoni* in *Heloderma suspectum* (Goldberg and Bursey, 1991b), and by *Diochetos phrynosomatis* in lizards of the genus *Phrynosoma* (Goldberg et al., 1993a). The life cycle of *O. scelopori* is unknown. Cysticercoids of *O. osheroffi* were recovered from both coleopteran and orthopteran insects (Widmer and Olsen, 1967). Coleoptera have been implicated as intermediate hosts for *Oochoristica anolis* in *Anolis carolinensis* from southeastern Louisiana (Conn, 1985). Thus, all studies of life cycles of species of *Oochoristica* to date indicate an insect intermediate host. *Sceloporus clarkii* and *S. undulatus consobrinus* are new host records for *O. scelopori* (Table 2).

Atractis penneri has been reported from 23 species of carnivorous lizards from North America (Baker, 1987, and Table 2). It is replaced in herbivorous lizards by *A. scelopori*. We recovered *A. penneri* from 4 of the 5 species examined from Arizona. A single *S. graciosus* harboring 286 *A. penneri* in the large intestine was examined from Washington County, Utah, which is adjacent and continuous to our Arizona collection site. Thus, although we did not record *A. penneri* from *S. graciosus* in Arizona, it has been previously reported from 8 other species of lizards from Arizona and had the highest mean intensity (1,682 in *S. magister*) of all the helminths we recovered (Table 2). *Atractis penneri* has been found in *S. graciosus* from Utah (Pearce

and Tanner, 1973) and California (Gambino and Heyneman, 1960). Third-stage larval atractids are known to autoinfect the host (Anderson, 1992). Baer (1951) suggested that these nematodes, which occur in such large numbers and in all stages of development in a single host, are possibly living on the partially digested vegetable matter and should be considered as commensals rather than true parasites. *Sceloporus virgatus* represents a new host record for *A. penneri* (Table 2).

Physaloptera retusa has been reported from 12 species of North American lizards (Bursey and Goldberg, 1991a). In Arizona, Goldberg and Bursey (1989a, 1990a) previously found *Cnemidophorus burti stictogrammus* and *S. jarrovii jarrovii* to harbor *Ph. retusa.* We recovered it from 4 of the 5 species examined in this study. The highest prevalence in our study (55%) was recorded for *Ph. retusa* in *S. clarkii.* As was the case for *A. penneri,* we found *P. retusa* in 1 *S. graciosus* from Washington County, Utah. *Physaloptera retusa* has previously been reported in *S. graciosus* from Utah and California (Woodbury, 1934; Goldberg and Bursey, 1989b). Although the life cycle has not been studied for *Ph. retusa,* the life cycles of 2 related species (*Ph. hispida* and *Ph. maxillaris*) have been examined in detail (Hobmaier, 1941; Schell, 1952; Lincoln and Anderson, 1975). Insects scavenging fecal material ingest physalopterid eggs, which hatch in their gut and then migrate into body tissue for subsequent development to third-stage larvae, infective to both definitive and paratenic hosts. *Physaloptera retusa* has been shown to cause ulcerative lesions in the stomach of sceloporine lizards (Goldberg and Bursey, 1989b). Records of *Physaloptera* sp. in Table 2 may well represent larvae of *Ph. retusa*; it is apparently incapable of reaching maturity in a number of lizard species (Goldberg et al., 1993c). *Sceloporus clarkii* and *S. virgatus* are new host records for *Ph. retusa* (Table 2).

Smith (1910) described *Filaria mitchelli* from *Heloderma suspectum* in the southwestern United States. Chabaud and Frank (1961) stated that the adult parasites from Smith's (1910) study should be placed in the genus *Piratuba* but the microfilariae in the *H. suspectum* blood belonged to another species. Sonin (1966) synonymized *F. mitchelli* with *Piratuba prolifica,* which has been reported from *Sceloporus mucronatus* from Mexico (Pelaez and Perez-Reyes, 1958) and *H. suspectum* from Arizona (Goldberg and Bursey, 1990d) under the synonym *Piratuba mitchelli.* The intermediate hosts are thought to be ticks (Smith, 1910; Pelaez and Perez-Reyes, 1958). *Sceloporus clarkii* is a new host record for *Pi. prolifica* (Table 2).

Skrjabinoptera phrynosoma, the only member of the genus *Skrjabinoptera* reported from North America, has been recovered from 20 lizard species in the United States and Mexico (Goldberg and Bursey, 1991a). Eight lizard species from Arizona have been reported previously to harbor *Sk. phrynosoma*; this report brings the number of infected lizards to 9. It is second only to *A. penneri* in terms of intensity (Table 2). Lee (1957) experimentally showed that the ant *Pogonomyrmex barbatus* served as an intermediate host for *Sk. phrynosoma.* Pearce and Tanner (1973) suggested that several species of ants may serve as intermediate hosts for this nematode. *Sceloporus clarkii* is a new host record for *Sk. phrynosoma* (Table 2).

Spauligodon giganticus has been found in 10 lizard species from western North America (Bursey and Goldberg, 1992a, and Table 2). *Sceloporus jarrovii, S. clarkii,* and *Urosaurus ornatus* are the only Arizona species previously to have been reported to harbor *Sp. giganticus* (Table 2). *Spauligodon giganticus* is thought to have a direct life cycle with infection occurring by fecal contamination of the substrate (Bursey and Goldberg, 1992a). Infection in *S. jarrovii* may occur shortly after birth (Goldberg and Bursey, 1992c). The presence of *Sp. giganticus* in lizards may be related to local climatic conditions. *Spauligodon giganticus* was present in *S. undulatus tristichus* but absent in *S. undulatus consobrinus.* The *S. undulatus tristichus* population was situated in a mesic environment on the top of the Santa Catalina Mountains (ca. 2,438 m) and was separated from the drier foothills population of *Sceloporus undulatus consobrinus* (ca. 1,280 m). Furthermore, Goldberg et al. (1993d) found higher prevalences of *Sp. giganticus* in New Mexico *Urosaurus ornatus* from a more mesic habitat as opposed to *U. ornatus* from a drier habitat. Similarly, Goldberg et al. (1993b) found *Sp. giganticus* present in New Mexico *Sceloporus poinsettii* but absent in a Texas population from a drier habitat. Finally, it is noteworthy that *Sp. giganticus* has not been found in *S. magister,* which occurs in xeric habitats. These observations suggest that moisture may be a limiting factor in *Sp. giganticus* distribution.

Nine of the 20 helminth species reported to

occur in Arizona lizards are harbored by sceloporine lizards. Two of these, *A. penneri* and *Sp. giganticus,* have direct life cycles, and infection may be gained through contact with contaminated substrate. Lizard population density may be important in determining infection intensities. The remaining 7 helminth species require an arthropod intermediate host. Diet may be most important in determining infection intensities for these species.

Sceloporus clarkii in Arizona harbors 7 species of helminths, *S. magister* 7, *S. jarrovii* 6, *S. undulatus* 4, *S. scalaris* 2, and *S. virgatus* 2 (Table 2). Thus, the sceloporine lizards with the largest body sizes (*S. magister, S. clarkii,* and *S. jarrovii*) contain the most diverse helminth faunas, whereas the smaller lizards (*S. scalaris* and *S. virgatus*) have the least. Whether or not having a larger digestive tract supports a more diverse helminth fauna is a question that warrents further investigation.

Acknowledgments

We thank the following for allowing us to examine specimens from their respective institutions: Robert L. Bezy and John W. Wright (LACM), Scott Cutler (MNA), and Jack W. Sites, Jr. (BYU).

Literature Cited

Anderson, R. C. 1992. Nematode Parasites of Vertebrates. Their Development and Transmission. C.A.B. International, Wallingford, Oxon, England. 578 pp.

Babero, B. B., and D. Matthias. 1967. *Thubunaea cnemidophorus* n. sp., and other helminths from lizards, *Cnemidophorus tigris,* in Nevada and Arizona. Transactions of the American Microscopical Society 86:173–177.

Baer, J. G. 1951. Ecology of Animal Parasites. University of Illinois Press, Urbana. 224 pp.

Baker, M. R. 1987. Synopsis of the Nematoda parasitic in amphibians and reptiles. Memorial University of Newfoundland, Occasional Papers in Biology, No. 11:1–325.

Benes, E. S. 1985. Helminth parasitism in some central Arizona lizards. Southwestern Naturalist 30: 467–473.

Bursey, C. R., and S. R. Goldberg. 1991a. Monthly prevalences of *Physaloptera retusa* in naturally infected Yarrow's spiny lizard. Journal of Wildlife Diseases 27:710–715.

———, **and** ———. 1991b. *Thubunaea intestinalis* n. sp. (Nematoda: Spiruroidea) from Yarrow's spiny lizard, *Sceloporus jarrovii* (Iguanidae), from Arizona, U.S.A. Transactions of the American Microscopical Society 110:269–278.

———, **and** ———. 1992a. Monthly prevalences of *Spauligodon giganticus* (Nematoda, Pharyngodonidae) in naturally infected Yarrow's spiny lizard *Sceloporus jarrovii jarrovii* (Iguanidae). American Midland Naturalist 127:204–207.

———, **and** ———. 1992b. *Oochoristica islandensis* n. sp. (Cestoda: Linstowiidae) from the island night lizard, *Xantusia riversiana* (Sauria: Xantusiidae). Transactions of the American Microscopical Society 111:302–313.

Chabaud, A. G., and W. Frank. 1961. Nouvelle filaire parasite des artères de l'*Heloderma suspectum* Cope: *Macdonaldius andersoni* n. sp. (Nematodes: Onchocercidae). Annales de Parasitologie Humaine et Comparée 36:127–134.

Conn, D. B. 1985. Life cycle and postembryonic development of *Oochoristica anolis* (Cyclophyllidea: Linstowiidae). Journal of Parasitology 7:10–16.

Gambino, J. J. 1958. *Cyrtosomum readi* n. sp. and *Cyrtosomum heynemani* n. sp. (Oxyuroidea: Atractidae) two new pinworms of iguanids. Journal of Parasitology 44:439–443.

———, **and D. Heyneman.** 1960. Specificity and speciation in the genus *Cyrtosomum* (Nematoda: Atractidae). American Midland Naturalist 63:365–382.

Goldberg, S. R. 1985. Larval cestodes (*Mesocestoides* sp.) in the liver of the island night lizard, *Xantusia riversiana.* Journal of Wildlife Diseases 21:310–312.

———. 1987. Larval cestodes (*Mesocestoides* sp.) in the giant spotted whiptail, *Cnemidophorus burti stictogrammus.* Journal of Herpetology 21:337.

———, **and C. R. Bursey.** 1989a. Helminths of the giant spotted whiptail, *Cnemidophorus burti stictogrammus* (Sauria: Teiidae). Proceedings of the Helminthological Society of Washington 56:86–87.

———, **and** ———. 1989b. *Physaloptera retusa* (Nematoda, Physalopteridae) in naturally infected sagebrush lizards, *Sceloporus graciosus* (Iguanidae). Journal of Wildlife Diseases 25:425–429.

———, **and** ———. 1989c. Larval nematodes (*Ascarops* sp.) in stomach granulomas of the sagebrush lizard, *Sceloporus graciosus.* Journal of Wildlife Diseases 25:630–633.

———, **and** ———. 1990a. Gastrointestinal helminths of the Yarrow spiny lizard, *Sceloporus jarrovii jarrovii* Cope. American Midland Naturalist 124:360–365.

———, **and** ———. 1990b. Helminths of the Arizona little striped whiptail, *Cnemidophorus inornatus arizonae,* and the desert grassland whiptail, *Cnemidophorus uniparens* (Sauria: Teiidae), from southeastern Arizona. Journal of the Helminthological Society of Washington 57:83–86.

———, **and** ———. 1990c. Prevalence of larval cestodes (*Mesocestoides* sp.) in the western fence lizard, *Sceloporus occidentalis biseriatus* (Iguanidae), from southern California. Bulletin of the Southern California Academy of Sciences 89:42–48.

———, **and** ———. 1990d. Redescription of the microfilaria *Piratuba mitchelli* (Smith) (Onchocercidae) from the Gila monster, *Heloderma suspectum* Cope (Helodematidae). The Southwestern Naturalist 35:458–460.

———, **and** ———. 1991a. Gastrointestinal helminths of the Mexican horned lizards, *Phrynosoma braconnieri* and *Phrynosoma taurus* (Iguanidae). Southwestern Naturalist 36:365–368.

———, **and** ———. 1991b. Gastrointestinal helminths of the reticulate Gila monster, *Heloderma suspectum suspectum* (Sauria: Helodermatidae). Journal of the Helminthological Society of Washington 58:146–149.

———, **and** ———. 1992a. Gastrointestinal helminths of the southwestern earless lizard, *Cophosaurus texanus scitulus,* and the speckled earless lizard, *Holbrookia maculata approximans* (Phrynosomatidae). Journal of the Helminthological Society of Washington 59:230–231.

———, **and** ———. 1992b. Helminths of the bunch grass lizard, *Sceloporus scalaris slevini* (Iguanidae). Journal of the Helminthological Society of Washington 59:130–131.

———, **and** ———. 1992c. Prevalence of the nematode *Spauligodon giganticus* (Oxyurida: Pharyngodonidae) in neonatal Yarrow's spiny lizards, *Sceloporus jarrovii* (Sauria: Iguanidae). Journal of Parasitology 78:539–541.

Goldberg, S. R., C. R. Bursey, and R. Tawil. 1993a. Gastrointestinal helminths of five horned lizard species *Phrynosoma* (Phrynosomatidae) from Arizona. Journal of the Helminthological Society of Washington 60:234–238.

———, ———, **and**———. 1993b. Gastrointestinal helminths of the crevice spiny lizard, *Sceloporus poinsettii* (Phrynosomatidae). Journal of the Helminthological Society of Washington 60:263–265.

———, ———, **and**———. 1993c. Gastrointestinal helminths of the western brush lizard, *Urosaurus ornatus* (Phrynosomatidae). Bulletin of the Southern California Academy of Sciences 92:43–51.

———, ———, **and N. Zucker.** 1993d. Gastrointestinal helminths of the tree lizard, *Urosaurus ornatus* (Phrynosomatidae). Journal of the Helminthological Society of Washington 60:118–121.

Hannum, C. A. 1941. Nematode parasites of Arizona vertebrates. Ph.D. Dissertation, University of Washington, Seattle. 153 pp.

Hobmaier, M. 1941. Extramammalian phase of *Physaloptera maxillaris* Molin 1860 (Nematoda). Journal of Parasitology 27:233–235.

Inglis, W. G., C. Diaz Ungria, and J. W. Coles. 1960. Nematodes de Venezuela, IV. Nematodes parasitos de vertebrados venezolanos, II. El género *Ozolaimus* (Oxyuridae: Pharyngodonidae). Acta Biologica Venezuelica 3:1–24.

Lee, S. H. 1957. The life cycle of *Skrjabinoptera phrynosoma* (Ortlepp) Schulz, 1927 (Nematoda: Spiruroidea), a gastric nematode of Texas horned toads, *Phrynosoma cornutum.* Journal of Parasitology 43:66–75.

Lincoln, R. C., and R. C. Anderson. 1975. Development of *Physaloptera maxillaris* (Nematoda) in the common field cricket (*Gryllus pennsylvanicus*). Canadian Journal of Zoology 53:385–390.

Margolis, L. G., G. W. Esch, J. C. Holmes, A. M. Kuris, and G. A. Schad. 1982. The use of ecological terms in parasitology (report of an ad hoc committee of the American Society of Parasitologists). Journal of Parasitology 68:131–133.

McAllister, C. T. 1991. First report of *Mesocestoides* sp. tetrathyridia (Cyclophyllidea: Mesocestoididae) in the Texas alligator lizard, *Gerrhonotus liocephalus* (Sauria: Anguidae), from Coahuila, Mexico. Texas Journal of Science 43:325–326.

———. 1992. Helminth parasites of unisexual and bisexual whiptail lizards (Teiidae) in North America. VIII. The Gila spotted whiptail (*Cnemidophorus flagellicaudus*), Sonoran spotted whiptail (*Cnemidophorus sonorae*), and plateau striped whiptail (*Cnemidophorus velox*). Texas Journal of Science 44:233–239.

———, **D. B. Conn, and S. E. Trauth.** 1992. Tetrathyridia of *Mesocestoides lineatus* (Cestoides: Cyclophyllidea) in *Sceloporus undulatus hyacinthinus* (Sauria: Iguanidae) from Arkansas. Journal of the Helminthological Society of Washington 59: 241–243.

———, **J. E. Cordes, D. B. Conn, J. Singleton, and J. M. Walker.** 1991a. Helminth parasites of unisexual and bisexual whiptail lizards (Teiidae) in North America. V. *Mesocestoides* sp. tetrathyridia (Cestoidea: Cyclophyllidea) from four species of *Cnemidophorus.* Journal of Wildlife Diseases 27: 494–497.

———, **S. E. Trauth, and D. B. Conn.** 1991b. Helminth parasites of unisexual and bisexual whiptail lizards (Teiidae) in North America. VII. The six-lined racerunner, *Cnemidophorus sexlineatus.* Texas Journal of Science 43:391–397.

Pearce, R. C., and W. W. Tanner. 1973. Helminths of *Sceloporus* lizards in the Great Basin and Upper Colorado plateau of Utah. Great Basin Naturalist 33:1–18.

Pelaez, D., and R. Perez-Reyes. 1958. *Piratuba prolifica* nov. sp. parasitica de un *Sceloporus* Mexicano. (Nemat. Filar.). Anales Escuela Nacional Ciencias Biologia, Mexico 9:49–59.

Schell, S. C. 1952. Studies on the life cycle of *Physaloptera hispida* Schell (Nematoda: Spiruroidea) a parasite of the cotton rat (*Sigmodon hispidus littoralis* Chapman). Journal of Parasitology 38:462–472.

Smith, A. J. 1910. A new filarial species (*F. mitchelli* n. s.) found in *Heloderma suspectum,* and its larvae in a tick parasitic upon the Gila monster. University of Pennsylvania Medical Bulletin 23:487–497.

Sonin, M. D. 1966. Filariata of animals and man and diseases caused by them. *In* Essentials of Nematodology. Vol. XVII. (Translated from Russian, Israel Program for Scientific Translations, Jerusalem, 1974. 365 pp.)

Stebbins, R. C. 1985. A Field Guide to Western Reptiles and Amphibians. Houghton Mifflin Co., Boston. 336 pp.

———, **and H. B. Robinson.** 1946. Further analysis of a population of the lizard *Sceloporus graciosus gracilis.* University of California Publications in Zoology 48:149–168.

Walker, K. A., and D. V. Matthias. 1973. Helminths of some northern Arizona lizards. Proceedings of

the Helminthological Society of Washington 40: 168–169.

Webster, J. P. 1949. Fragmentary studies on the life cycle of the cestode *Mesocestoides latus*. Journal of Parasitology 35:83–90.

Widmer, E. A., and O. W. Olsen. 1967. The life history of *Oochoristica osheroffi* Meggit, 1934 (Cyclophyllidaea: Anoplocephalidae). Journal of Parasitology 53:343–349.

Woodbury, L. A. 1934. Notes on some parasites of three Utah reptiles. Copeia 1934:51–52.

Appendix

Museum Accession Numbers, Locality Data, and USNM Helminthological Collection Numbers

Sceloporus clarkii: Gila County, Arizona: LACM 139987, 33°36′N, 111°12′W, 609 m elevation. Mohave County, Arizona: LACM 139986, 35°26′N, 113°38′W, 1,219 m elevation. Pima County, Arizona: LACM 140101–140102, 31°95′N, 111°59′W, 1,884 m elevation; LACM 140092–140094, 140098, 140100, 140103–140104, 32°20′N, 110°49′W, 883 m elevation. Pinal County, Arizona: LACM 140095–140097, 32°30′N, 110°43′W, 1,417 m elevation; LACM 140099, 32°51′N, 111°27′W, 1,219 m elevation. Yavapai County, Arizona: MNA 1762, 1767, 1770, 1772–1773, 34°40′N, 111°46′W, 1,169 m elevation. USNM Helm. Coll. Nos.: *Mesocestoides* sp., 82711; *Oochoristica scelopori,* 82712; *Atractis penneri,* 82713; *Physaloptera retusa,* 82715; *Piratuba prolifica,* 82714; *Skrjabinoptera phrynosoma,* 82716; *Spauligodon giganticus,* 82717.

S. graciosus: Coconino County, Arizona: BYU 37876–37888, 36°06′N, 111°20′W, 1,383 m elevation. Navajo County, Arizona: LACM 95730–95735, 97551, 36°56′N, 110°26′W, 1,859 m elevation. Washington County, Utah: BYU 37388, 37°13′N, 112°57′W, 1,473 m elevation. USNM Helm. Coll. Nos.: *Atractis penneri,* 82718; *Physaloptera retusa,* 82719.

S. magister: Gila County, Arizona: LACM 139993, 33°36′N, 111°12′W, 609 m elevation. Mohave County, Arizona: LACM 139990, 34°32′N, 113°44′W, 827 m elevation; LACM 139992, 35°06′N, 114°06′W, 846 m elevation. Pima County, Arizona: LACM 140112–140114, 140117, 32°20′N, 110°49′W, 907 m elevation; LACM 140118, 32°02′N, 111°32′W, 944 m elevation; LACM 140110–140111, 140115–140116, 32°15′N, 110°05′W, 731 m elevation. Pinal County, Arizona: LACM 140119, 32°36′N, 110°51′W, 1,158 m elevation. Yavapai County, Arizona: LACM 139988–139989, 34°36′N, 113°08′W, 1,248 m elevation. USNM Helm. Coll. Nos.: *Atractis penneri,* 82720; *Physaloptera retusa,* 82721; *Skrjabinoptera phrynosoma,* 82722.

S. undulatus consobrinus: Pinal County, Arizona: LACM 140120–140149, 32°36′N, 110°51′W, 1,158 m elevation. USNM Helm. Coll. Nos.: *Oochoristica scelopori,* 82723; *Physaloptera retusa,* 82724.

S. undulatus tristichus: Pima County, Arizona: LACM 140150–140167, 32°26′N, 110°45′W, 2,438 m elevation. USNM Helm. Coll. Nos.: *Mesocestoides* sp., 82725; *Physaloptera retusa,* 82726; *Spauligodon giganticus,* 82727.

S. virgatus: Cochise County, Arizona: LACM 140168–140190, 31°58′N, 109°22′W, 1,700 m elevation. USNM Helm. Coll. Nos.: *Atractis penneri,* 82728; *Physaloptera retusa,* 82729.